RH567 Motional Feedback System

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PHILIPS HIGH FIDELITY LABORATORIES, LTD.

SERVICE DEPT. P.O.BOX 2208 FORT WAYNE, INDIANA 46801

PHILIPS

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LIST OF ILLUSTRATIONS

TECHNICAL DATA*

General

Frequency Response:
27-20,000 Hz

Volume:
30 litres (20 litres acoustic),(1831 cu. inches acoustic).

Loudspeakers:
AD10100/MFB, 10" Woofer
AD0210/SQ8, 2" Dome Mid-Range
AD0140/T8, 1" Dome Tweeter

Power Supply:
117 Volts, 60 Hz

Power Consumption, Maximum:
150 Watts

Dimensions:
320 x 540 x 265mm (13 x21¼ x 10¾ inches)

Treble Filter:
Continuously variable 0-18dB/Octave, -3dB at 7 KHz.

Crossover Networks:
Electronic Crossover at 500 Hz.
Passive Crossover at 3500 Hz.

Connections:
Signal: PHONO jacks (2 input, 2 output)
AC inlet
AC outlet (unswitched)

Input Sensitivity:
Continuously variable 1-3 volts at 100K ohms, 3-20 volts at 1K ohm.

Automatic On/Off Switch:
Turn-On time $\leq$ 1 second, with an input signal $\geq$ 2mV.
Turn-Off time $>$ 2 minutes

Amplifiers

Low Frequency Amplifier:
Minimum "RMS" Power: 40 Watts RMS
Bandwidth: 35 Hz to 1000 Hz
Maximum Total Harmonic Distortion: 0.2%
Load Impedance: 4 ohms

High Frequency Amplifier:
Minimum "RMS" Power: 20 Watts RMS
Bandwidth: 400 Hz to 20 KHz
Maximum Total Harmonic Distortion: 0.2%
Load Impedance: [illegible] ohms

* Subject to Modification

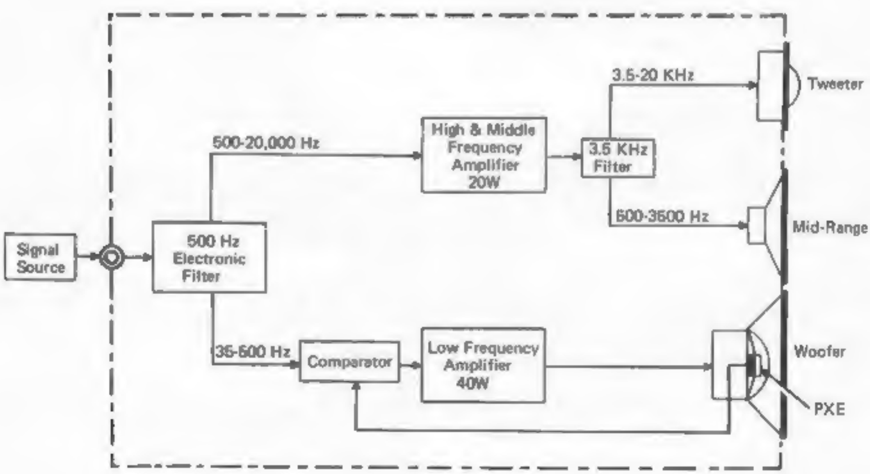


Figure 1, Block Diagram

General Description

The RH567 is an electronic, bi-amplified, three-way loudspeaker system employing the PHILIPS Motional Feedback (MFB) principle.

The enclosure, which has a total volume of 30 liters, incorporates three driver units, an electronic regulator and control system, and two power amplifiers: one for the woofer and one for the mid-range and tweeter. The woofer (low frequency) amplifier is terminated in a 4 ohm load impedance and has a minimum continuous average sine wave (RMS) power of 40 watts. The mid-range/tweeter (high frequency) amplifier, which is of similar design to the low frequency amplifier, is terminated in an 8 ohm load impedance, and is, therefore, limited to an output power of 20 watts. An electronic crossover is used to divide the input signal between the two power amplifiers. This crossover consists of a high-pass filter feeding the high frequency amplifier, and a low-pass filter feeding the low frequency amplifier. Both filters have a cut-off point of 500 Hz, resulting in amplifier crossover at that frequency.

Since it is physically impossible for the woofer cone to produce frequencies below 25-35 Hz at a moderate sound pressure level without resulting in high non-linear distortion, the response of the low frequency amplifier is rolled-off below 40 Hz by a high-pass filter placed immediately after the low-pass filter section of the electronic crossover.

The output of the high frequency power amplifier feeds a typical passive crossover network with a crossover point of 3500 Hz. The high-pass section of this crossover feeds the 1" dome-type tweeter, while the low-pass section feeds the 2" dome mid-range. The output of the low frequency power amplifier feeds the 10" MFB woofer.

The woofer consists of a standard 10" driver with an accelerometer mounted under the dust cover at the apex of the cone. It is, in fact this piezoelectric transducer (PXE) which constitutes the most important aspect of the entire system. Its function is to measure the acceleration of the woofer cone, which is exactly proportional to its acoustic output as long as the cone moves as a single, rigid "piston". This requirement forms part of the reasoning behind the 500 Hz crossover point; as above this frequency the cone will begin to move independently in small areas, resulting in less correlation between central acceleration and acoustic output.

The signal developed by the PXE is fed to a comparator circuit which derives a correction signal from any differences between the input signal and the woofer cone acceleration signal. This correction signal is combined with the input signal and fed to the low frequency amplifier, resulting in considerable reduction of distortion attributable to the loudspeaker, and keeps the acoustic output virtually identical to the input signal waveform. This is the principle of motional feedback.

CIRCUIT DESCRIPTION

Before examining the individual circuits in detail, it would be useful to know the construction of the acceleration transducer assembly.

As mentioned, the Motional Feedback transducer is mounted under the dust cover in the apex of the woofer cone, where it is in rigid mechanical contact with the voice coil assembly. The transducer consists of a small printed circuit board containing the ceramic piezoelectric transducer and its associated FET circuitry. The mounting of the piezoelectric chip is quite critical: It is held in place in a small hole in the PC board by two resilient rubber clamps, allowing a calculated degree of flexure due to the cone's acceleration. The leads to the chip are fastened to the PC board by two carefully weighed drops of solder . . . a most important consideration if assembly mass is to be accurately controlled.

As piezoelectric transducers (generators) are capacitive voltage sources, they must be loaded with a high impedance to obtain a linear frequency response from them. However, high impedance circuits running long distances (such as, from the motional feedback transducer back into the power amplifier) are quite susceptible to noise. Therefore, a junction FET has been used in the assembly as an impedance converter. It will be noticed that the circuit configuration is rather unusual in that the FET drain feeds the emitter of TS436 instead of the base. There are two benefits to this approach. First, the FET source provides a relatively low source impedance to reduce susceptibility to noise. Second, the common base operation of TS436 makes the driving signal a "varying resistance" rather than a "varying voltage". In other words, the base voltage of TS436 is fixed by the voltage divider network made up of R677, R680, R678, R679, and zener diode D462; and the conduction of TS436 is controlled by varying the value of its emitter "resistor", the FET.

This "dynamic resistance" drive signal makes the circuit quite insensitive to any noise signal voltage which might appear on the signal lead, as the gain from a voltage input at the emitter is very low. It will be further noticed that the collector voltage of TS436 is Zener stablized. This is to place the quiescent operating point on the center of the transistors curve, as the static conduction of TS436 regulates the source-to-drain bias on the FET, which must be carefully held below a maximum value to preserve the gates high input impedance.

Amplifier System Input

At the signal input to the Motional Feedback System are four phono jacks. These are connected in two individual pairs: left input and output, and right input and output; to allow the interconnection of two or more Motional Feedback Systems while carrying both (stereo) channel signals through the interconnection wiring. These jack pairs feed the input channel selector switch (SK-B) which allows the user to choose whether the particular Motional Feedback System is driven by the left or right channel signal.

Following the input channel selector switch the signal is attenuated to the proper level by the input Sensitivity Control, R416, and applied to an emitter follower stage, TS421. The signal then passes through a frequency selective network which allows the frequencies over 7 KHz to be rolled off by the High Frequency Roll Off Control, R417.

After passing through another emitter follower (TS422) the signal is applied to the active crossover filters which determine the input to the power amplifiers.

High Frequency Amplifier

At the high frequency amplifier input there is an active high-pass filter. As is normally the case this filter is partially contained in the emitter to base feedback loop around the first transistor, TS441. The slope of the filter is 18db/octave, and its -3db point is 500 Hz.

The amplifier itself is of a common design. Its operation is class A/AB to eliminate crossover distortion at low signal levels. Up to about 1W of output power the amplifier

operates in a class A configuration and changes to class AB at higher input signal levels.

Each output stage is comprised of a single-chip Darlington device, assuring that the two transistors involved are completely complementary. To insure thermal stability of the Darlington pair, a negative temperature coefficient resistor (thermistor), R719, is used in the bias control circuit, and is mounted on the Darlington package heat sink along with TS442, which is also part of the quiescent bias control.

The LC networks C566-S492 and C568-S493, respectively, form high-pass and low-pass filters for the tweeter and mid-range speakers. Together they form a conventional passive crossover network. The series RC network across the mid-range is for impedance correction at high frequencies. Coil S491 is a normal high frequency neutralizing choke.

Low Frequency Amplifier

At the input of the low frequency channel is a low-pass filter, TS423. This circuit is similar to the 500 Hz high-pass filter incorporating TS441, and likewise has a slope of 18db/octave. Since TS423 is in the emitter follower configuration its output appears at the emitter, from which it is coupled to the base of the next stage. This stage, a high-pass filter, is made up of TS424 and associated components, and is again arranged in the emitter follower configuration. The circuit acts as a rumble filter and attenuates all frequencies below approximately 35 Hz at 12db/octave. This makes the frequency response the same as that of a speaker with a natural resonance of 35 Hz.

The signal, bandwidth limited by filters to 35-500 Hz, is applied to the adding stage, TS425, where it is combined with the feedback signal derived from the accelerometer circuit. The feedback signal arrives at the base of TS425 via C518 and R627. The "normal" input signal is applied via C516 and R634. The gain factor of this adding circuit is approximately one. The combined signal is then coupled to a differential amplifier consisting of TS428 and TS429. This stage is used to shape the electrical feedback signal, which is taken from the load side of C535 (TP 1).

The low frequency amplifier operates class B. Since the frequency range does not exceed 500 Hz, practically no higher harmonics will be produced by the woofer and subsequently the possibility of crossover distortion is effectively suppressed without the need for class A/AB operation. Like the high frequency amplifier discussed earlier, each output stage is comprised of a single chip Darlington device. The thermistor, R662, is used for thermal stability and is mounted on the heat sink along with TS430 which is also part of the quiescent bias control. The output from the low frequency amplifier is coupled through C535 to the woofer.

The signal from the woofer/transducer assembly is applied to the emitter of TS436, as explained earlier in the circuit description. A prominent feature of the collector circuit of this transistor is the zener diode, D462, which is used to smooth the power supply voltage. If an electrolytic capacitor were used, the circuit would start oscillating (motorboating) at low frequencies. The signal is coupled from the collector of TS436 to the frequency correction stage consisting of TS437 and TS438. Down to approximately 80 Hz the correction stage has a flat frequency response. Below that the signal has an increasing gain slope of 6db/octave. The reason is the natural resonance of the loudspeaker, which in this case is also about 80 Hz.

In the flat part of the response the signal is amplified by a factor of only two or three, while below 80 Hz the gain increases to a factor of about 20. Two transistors, TS437 and TS438, were used to avoid distortion. The signal at the output of the frequency correction stage is coupled through C542 to R692 where the feedback level may be adjusted. From the wiper of R692 the signal is coupled through C518 and R627 to the adding stage which was discussed earlier.

Automatic Electronic On/Off Switch

The arrangement for switching the system On and Off has a special feature. The circuit consisting of TS447 through TS452 "senses" when a signal is applied to the speaker system and applies power to the high and low frequency amplifiers. This feature is operative only when both the Power and Automatic switches are in the "On" position. With the Automatic switch in the "Off" position the Power switch must be used to turn the system On and Off.

The input signal is applied to the gate of TS447. The output of this stage is coupled via C578 and R743 to the stage comprised of TS448 and TS449 where it is amplified and rectified. When the input signal exceeds a preset level the Schmitt trigger, TS450 and TS451, changes states and turns on the Relay Driver, TS452, which in turn energizes the relay, RE402.

A time delay circuit located immediately ahead of the Schmitt trigger will keep the relay from de-energizing during short no-signal periods; such as at the end of a record or tape. If no signal is applied to the unit within approximately 2 minutes the Schmitt trigger will change states and the relay will de-energize. With the relay de-energized only sources +6, +7 and +8 have power applied to them. The Power switch must be placed in the "Off" position to remove power from the entire unit.

Overload Circuit

The treble speaker (tweeter) is protected against overload conditions which might occur when the speaker must produce a maximum output for a long period of time. Experience has shown that the tweeter is more vulnerable to overloads than the woofer and the mid-range.

The signal across the tweeter is rectified by D465 and filtered by R735 and C572. Since R735 and C572 also form an RC network with a time constant of 1 second, the positive voltage at the base of TS446 developes rapidly. Being an emitter follower, the voltage on the emitter increases along with the base. The output obtained at the emitter of TS446 is coupled through the voltage divider network comprised of R737 and R761 to the base of TS440.

During an overload condition the output of TS446 causes the Schmitt trigger (TS439-TS440) to change states, thus driving TS426 into conduction. With TS426 conducting, the signal at R608 is shunted to ground through TS426 and C508, and output power is reduced to near zero.

This reduction in loudness is an indication for the listener that the Volume control should be turned slightly counter-clockwise. From this moment C572 will discharge via TS446 until the emitter voltage reaches such a low value that the Schmitt trigger (TS439-TS440) changes states again shutting off TS426. The music signal then passes on without attenuation.

Power Supply

The power supply circuits are conventional. Only the supply voltage for the preamplifiers (source +7) is electronically regulated (TS455-TS456). The circuit also ensures that this voltage increases slowly to the correct level, as is necessary to prevent switching transients. This is a point to which great care must be paid in circuits with a bandwidth extending down to very low frequencies.

OPERATING CONTROLS, JACKS, AND INDICATORS
(Refer to Figures 2 and 3)

1. **Power Switch:** This is the main power switch and must be on for the unit to operate.
2. **Automatic Switch:** With this switch off, the unit functions normally by using the Power Switch. With the Automatic Switch and the Power Switch in the on position the unit operates on a "standby" basis. Part of the power supply is energized at all times, and the rest of the power supply energizes when a signal is applied to the unit. When the signal is removed from the unit it will return to the "standby" condition after a short delay. To turn the unit off completely the Power Switch must be in the off position. The pilot lamp (LED) is not lit in the "standby" or off condition.
3. **Fuse Holder** (fuse 6.25ASB, 125V)
4. **Fuse Holder** (fuse 3A SB, 250V)
5. **Fuse Holder** (fuse 1.5A SB, 250V)
6. **High Frequency Roll Off Control:** This control allows you to choose the slope of roll off, in dB per octave, for those frequencies above 7K Hz.
7. **Input Sensitivity Control:** This control allows you to match the speaker system to your amplifier or preamplifier. The control should be set for the output voltage of the equipment being used to drive the speaker system. If the driving equipment is rated in watts RMS rather than volts, refer to Figure 7.
8. **Signal Input Jack, Left Channel:** Receives the left channel output signal from the driving equipment.
9. **Signal Input Jack, Right Channel:** Receives the right channel output signal from the driving equipment.
10. **Signal Output Jack, Left Channel:** Relays the left input signal for feed-thru hook-up to other MFB.
11. **Signal Output Jack, Right Channel:** Relays the right input signal for feed-thru hook-up to other MFB.
12. **Input Channel Selector Switch:** Determines which channel input will be amplified by that particular speaker assembly.

IMPORTANT: Take special care that the connections for Left and Right on the control unit are not interchanged.

13. **AC-Inlet** (117 Volts, 60 Hz).
14. **AC-Outlet** (117 Volts, 60 Hz, 550 Watts) Unswitched.
15. **Pilot Lamp (LED), on front panel:** This lamp, when lit, indicates that the speaker unit is completely operative. When the unit is in the "standby" condition or completely off the indicator is not lit.

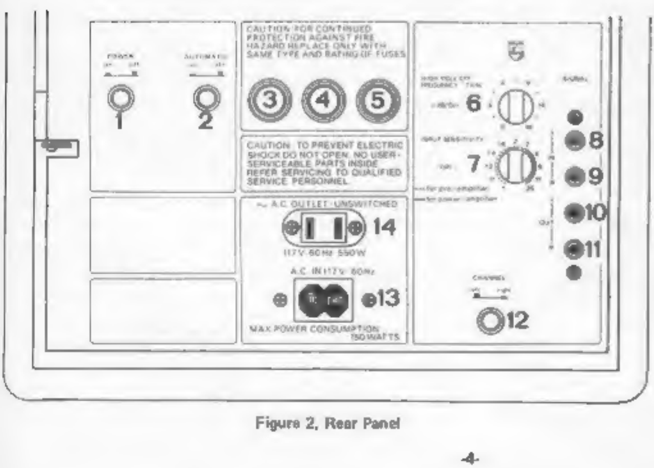


Figure 2, Rear Panel

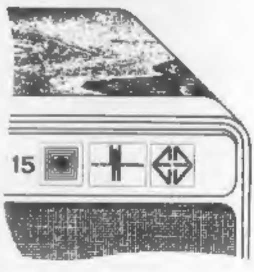


Figure 3, Front Panel

DISASSEMBLY INSTRUCTIONS

NOTE: To insure proper reassembly, replace each screw in the same location from which it was removed.

Chassis Access (Refer to Figure 5)

1. Remove the five screws securing the rear panel to the speaker enclosure. These screws are designated by an "0" on the rear panel and an "A" in Figure 5.
2. The rear panel is hinged, allowing it to swing away from the back of the speaker enclosure. Pull out on the right side of the rear panel to gain access to the chassis.
3. To completely remove the rear panel from the speaker enclosure, disconnect Plug (4) from Socket (2) and lift the rear panel up and out of the hinge brackets.
4. To reassemble, reverse the preceding steps, making certain Plug (4) is inserted properly into Socket (2). This is accomplished by placing the referenced end of the plug adjacent to the referenced end of the socket.

LED Access (Refer to Figure 5)

1. Remove the three screws securing the Name Panel (19) on the front of the speaker assembly. Then pull outward on the Name Panel to gain access to the LED.
2. To reassemble, reverse the preceding steps, making certain the LED is properly positioned into the Name Panel (19).

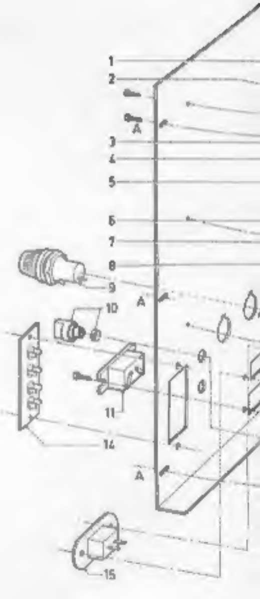
Speaker Access (Refer to Figures 4 & 5)

1. Insert a table knife or similar dull-edged tool between the Grille (20 or 21) and the speaker enclosure frame.
2. Draw the Grille (20 or 21) forward while prying outward with the tool. The Grille is held to the speaker enclosure by friction snaps.
3. To reassemble, place the Grille (20 or 21) into position while aligning the snaps. Then press firmly at the corners.

Figure 4, Grille Removal

Main PC Board Access (Refer to Figure 5)

1. Swing the rear panel away from the back of the speaker enclosure (see Chassis Access).



2. Remove the six screws securing the Main PC Board / Heat Sink to the rear panel.
3. The Main P.C. Board/Heat Sink is hinged to the inside of the rear panel, allowing it to swing away for easy access to either side of the P.C. Board.
4. To remove the Main P.C. Board/Heat Sink from the rear panel, lift it up and out of the hinge brackets.
5. To reassemble the Main P.C. Board/Heat Sink, reverse the preceding steps.

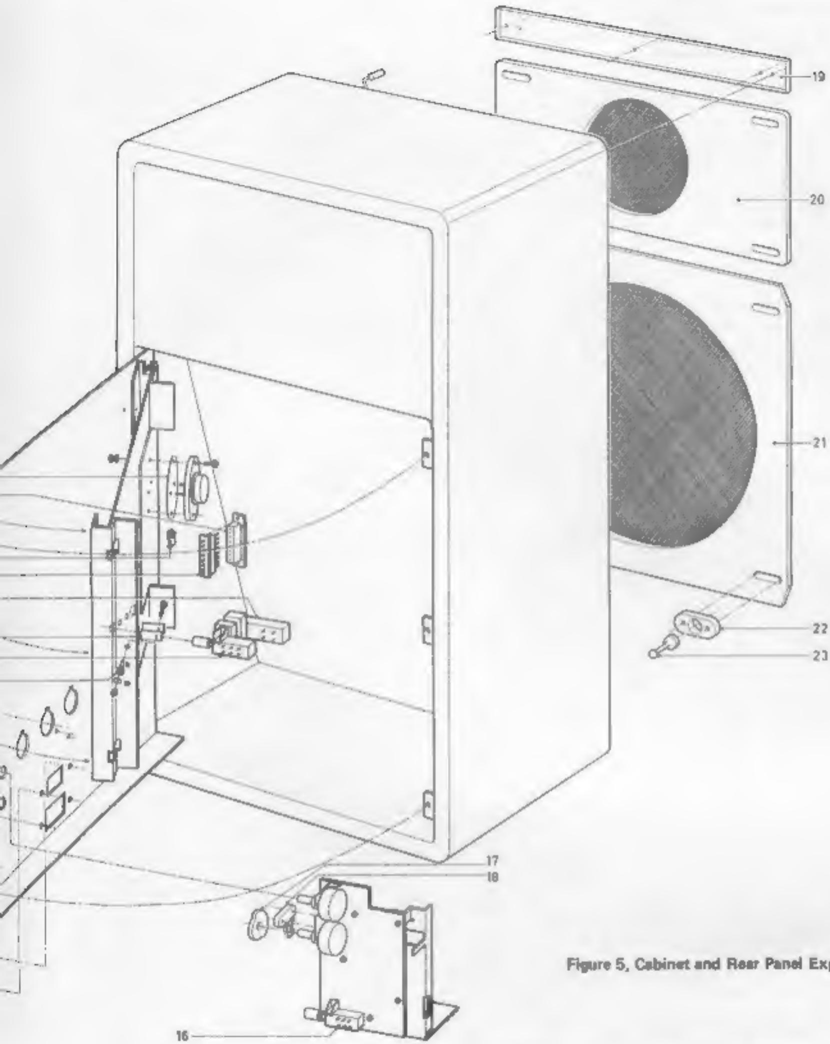


Figure 5, Cabinet and Rear Panel Exploded View

Board /

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he rear

reverse

CABINET REPLACEMENT PARTS LIST (Refer to Figure 5)

REF.	DESCRIPTION	PART NO.
1	Mica Insulator f/TS432a & TS432b (2 used)	5H46690433
2	8 Pin Socket	4H26750221
3	Bracket f/TS442 & TS430 (2 used)	4H25540127
4	8 Pin Plug	4H26450081
5	AC Switch (SK-A-1)	4H27610564
6	Mica Insulator f/TS444a & TS444b (2 used)	4H25540112
7	Automatic Switch (SK-D-111)	4H27610616
8	Insulator Bushing f/TS432a, TS432b, TS444a & TS444b (6 used)	4H53251043
9	Fuse Holder (3 used)	4H25640048

REF.	DESCRIPTION	PART NO.
10	Knob,w/Compression Spring (2 used)	4H41330623
11	AC Inlet (Interlock)	4H26520062
14	Jack Assembly (Input/Output)	4H26740222
15	AC Outlet	4H26730255
16	Channel Selector Switch (SK-B-11)	4H27610616
17	Disc Cam f/SK-E-1V	4H53260643
18	Input Impedance Switch (SK-E-1V)	4H27690303
19	Name Panel	4H45910476
20	Grille (Small)	4H44530042
21	Grille (Large)	4H44530043
22	Locking Pin Holder (8 used)	4H46690844
23	Locking Pin (8 used)	4H41720039

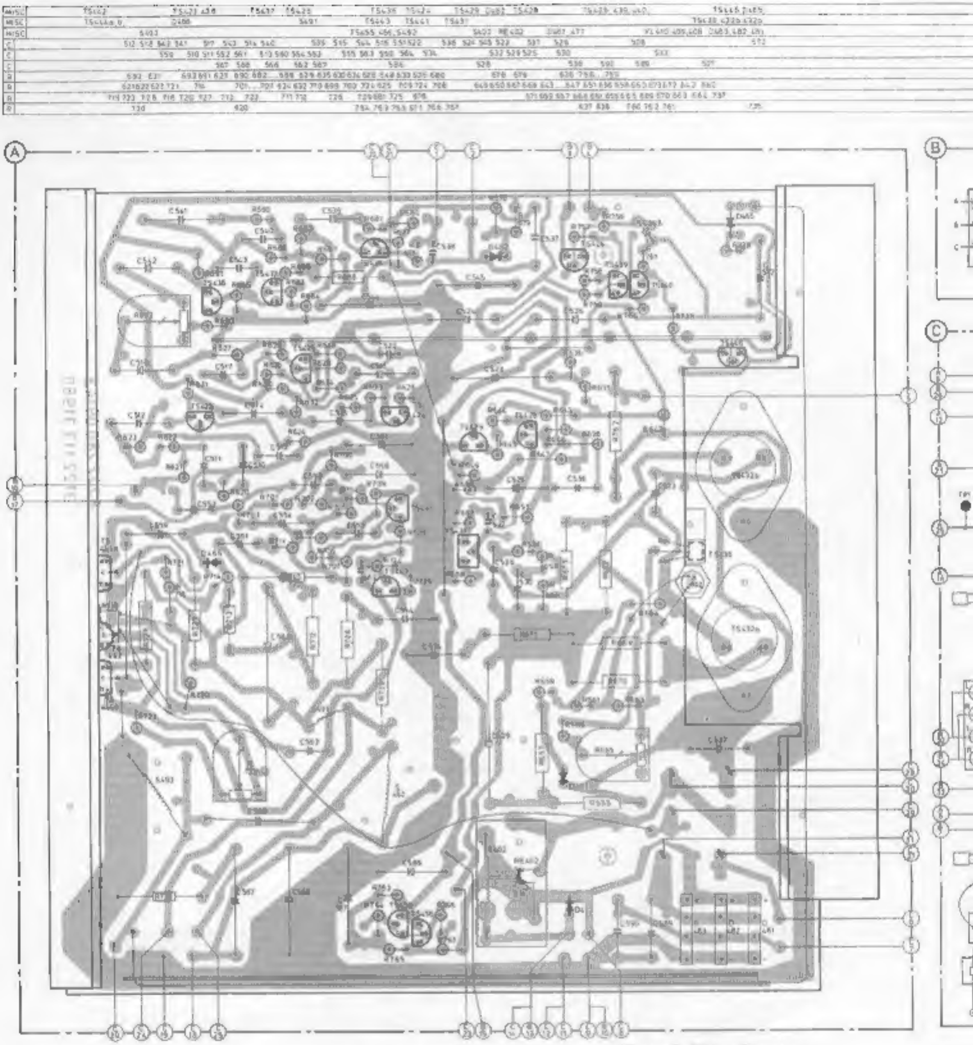


Figure 6, Wiring Diagram

Output of Driving Amplifier (Rated in Watts, RMS)

		4 Ohm Load	8 Ohm Load
Input Sensitivity Control Setting	3 V	< 5 W	< 2.5 W
	4 V	5 - 10 W	2.5 - 5 W
	6 V	10 - 30 W	5 - 15 W
	11 V	30 - 100 W	15 - 50 W
	20 V	>100 W	> 50 W

Figure 7, Input Sensitivity Chart

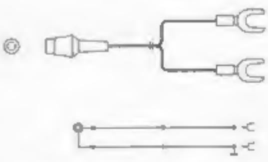
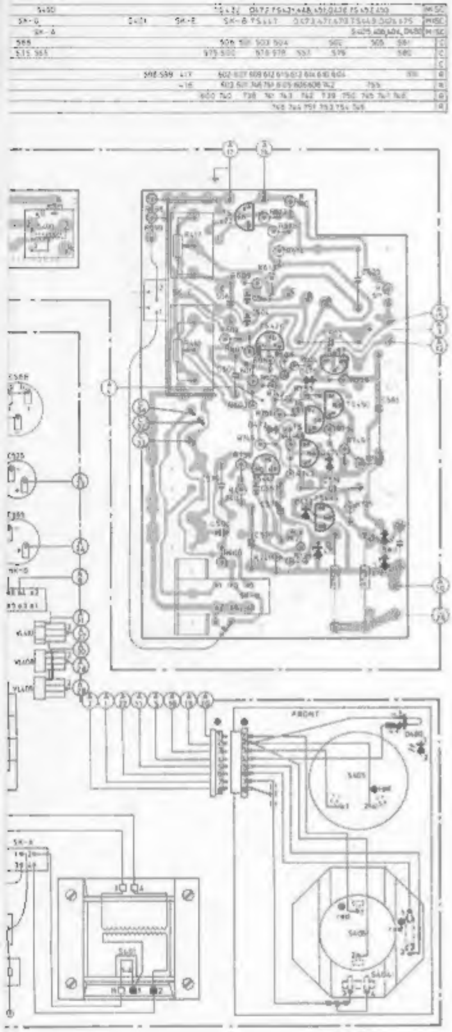


Figure 8, Adapter Cable Drawing



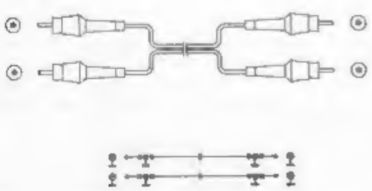


Figure 9, Stereo Cable Drawing

ADJUSTMENTS

IMPORTANT: The amplifier circuitry should be allowed to warm-up for 1-1½ minutes to stabilize prior to final adjustments.

Low Frequency Amp Quiescent Current Adjustment

To adjust the complementary symmetry push-pull output stage of the low frequency amplifier:

1. Switch the speaker system On and remove the audio input signal.

2. Connect a DVM across R670 and adjust R665 for 37.5 mV.

NOTE: This adjustment must be performed when the low frequency amplifier output transistors are replaced. Misadjustment may cause crossover distortion or possible premature failure of the output transistors.

High Frequency Amp Quiescent Current Adjustment

To adjust the complementary symmetry push-pull output stage of the high frequency amplifier:

1. Switch the speaker system On and remove the audio input signal.

2. Connect a DVM across R727 and adjust R722 for 35mV.

NOTE: This adjustment must be performed when the high frequency amplifier output transistors are replaced. Misadjustment may cause crossover distortion or possible premature failure of the output transistors.

Motional Feedback Adjustment

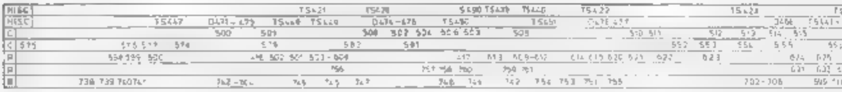
To adjust the amount of feedback produced by the frequency correction circuit:

1. Switch the speaker system On and place the Input Sensitivity Control, located on the rear panel, to the 1V position. Connect an AC VTVM to TP1.

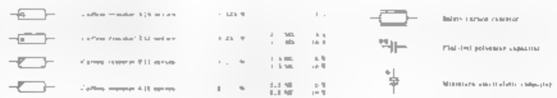
2. With a low impedance (less than 100 ohms) Audio Generator apply a 10 mV RMS, 125 Hz signal to the Audio Input Jack located on the rear panel. Place the Channel Selector Switch in the proper position to amplify the signal.

3. Adjust R692 for 82 mV.

NOTE: This adjustment must be made after replacing a bass speaker (woofer).



1 nf = .001 uf
10 nf = .01 uf
100 nf = .1 uf



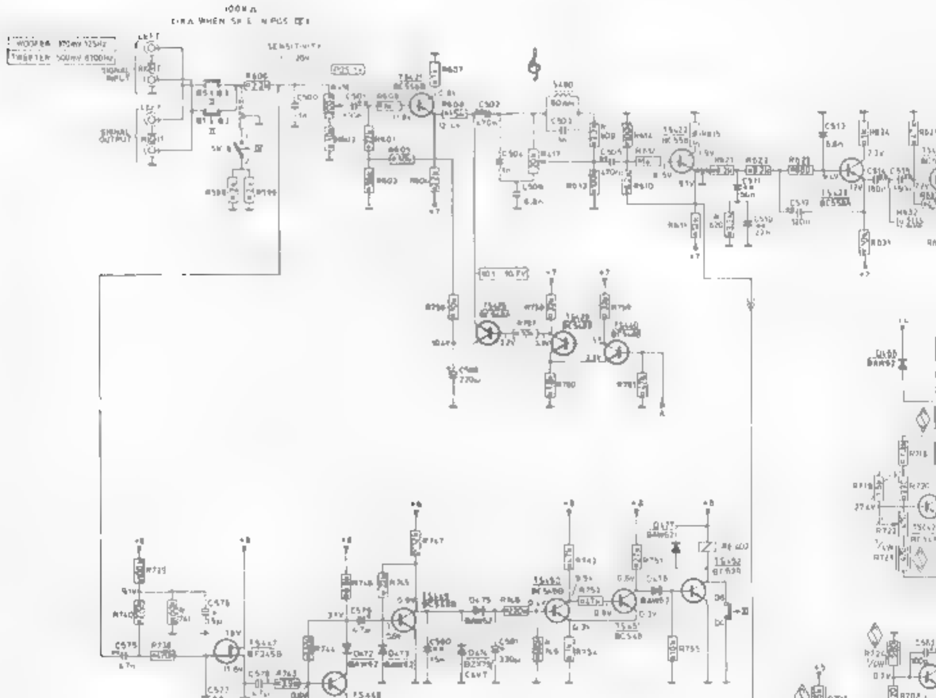


Figure 10, S

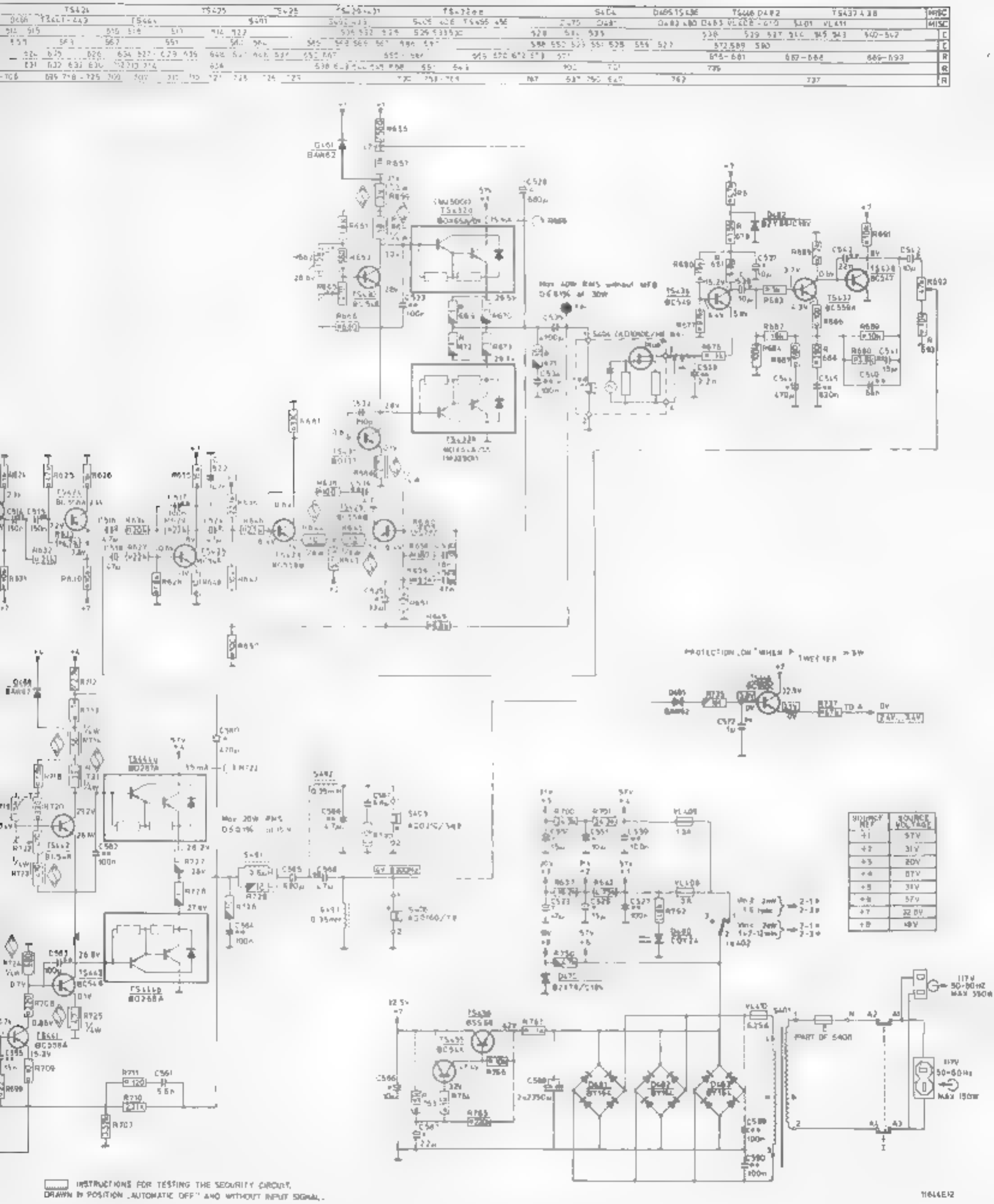


Figure 10, Schematic Diagram

MISC	D465, TS446 TS440,439,426 TS428 D462 TS429 TS424 TS436 TS425 TS437
MISC	TS432b,430,432a TS431 TS441,443 S491
MISC	D481, 482, 483 VL408...410 D477 451 RE402 S402 TS456 455 S492
C	572 508 526 537 523 545 524 538 522 551 516 544 515 539 540 514 54
C	533 530 525 529 532 534 550 563 555 553 554 560 513 561 5
C	527 589 590 536 528 586 564 587 562 566 568 56
R	756...759 636 679 678 677 680 626 633 648 628 634 630 635 629 682...688 690
R	735 662 542 762 673 660 665 651 643...647 668 667 650 649 708 724 709 700 704 599 710 632 624
R	737 663 750 669 655 661 666 657 671 656 725 729 681 726 705 712 707 722
R	761 664 638 637 672 670 658 659 767 766 576 765 763 764 625 702 706 701

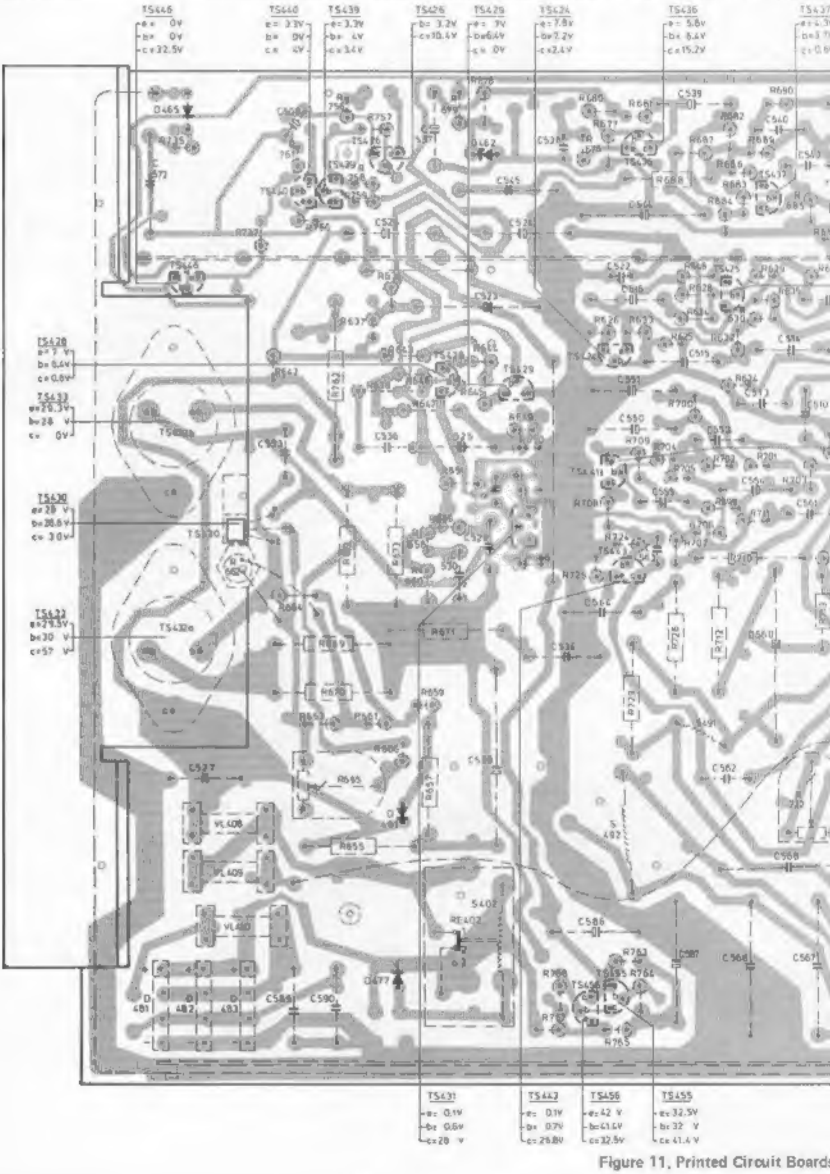
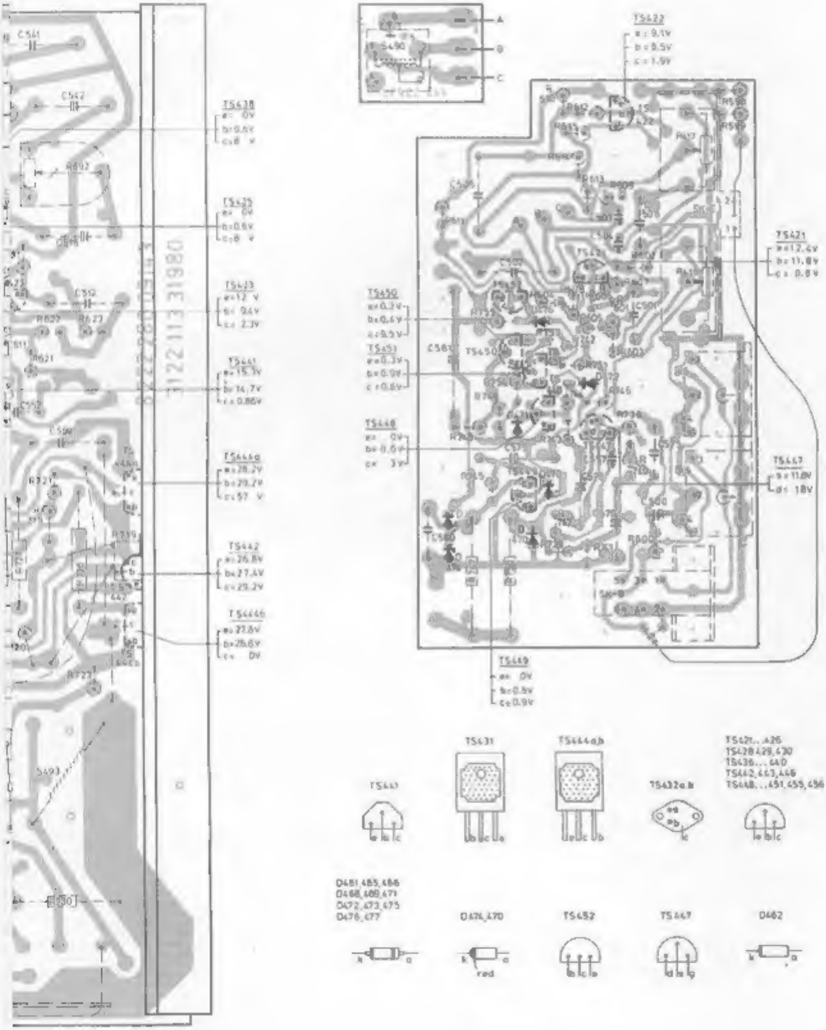


Figure 11. Printed Circuit Boards

38, 423 S490 TS450, 452 D476 TS451, 448 D472 TS422	MISC
66 TS422, 444a,b D475, 474 TS448 D470, 741, 473 TS447 TS421 SK-E	MISC
S493 SK-B	MISC
541 542 518 512 581 505 502 504 503 501 506	C
559 580 579 537 576 500 575	C
578	C
91 693 627 631 692 611 604 610 614 613 615 612 609 607 602 508 417 598 599	R
14 721 623 622 621 755 753 744 742 608 606 605 751 748 601 603 416	R
27 720 718 728 723 746 747 745 750 739 743 764 741 740 600	R
0 730 719 754 749 746 738	R



th Test Points and Basing Diagrams

OUTPUT TRANSISTOR REPLACEMENT

Since transformerless complementary symmetry push-pull output circuitry is utilized in the motional feedback system, extreme care should be exercised when servicing or replacing the output transistors. It is imperative that the transistor be isolated from the metal bracket by means of a mica insulator coated on both sides with Dow-Corning DC4 silicon grease, or equivalent. Before removal of an output transistor, the type (PNP or NPN) should be noted to insure the identical replacement is reinserted into the same holes of the P.C. Board.

The output transistors in both the low and high frequency amplifiers should be replaced with matched pairs, as indicated in the Electrical Replacement Parts List. After replacing the low frequency amplifier output transistors the Low Frequency Amp Quiescent Current Adjustment must be performed. Likewise, if the high frequency amplifier output transistors are replaced the High Frequency Amp Quiescent Current Adjustment must be performed. Misadjustment of the output transistors may cause cross-over distortion and possible premature failure of the output transistors.

ELECTRICAL REPLACEMENT PARTS LIST

REF.	DESCRIPTION	PART NO.
	COILS & TRANSFORMERS	
S401	Power Transformer	4H14550059
S490	Coil, 60 mH	4H15610346
S491	Coil, 3.6 uH	4H15750718
S492	Coil, .35 mH	4H15750809
S493	Coil, .35 mH	4H15750809
	CAPACITORS	
C508	Electrolytic, 220 mfd.,16V	4H12420473
C516	Electrolytic, 4.7 mfd.,63V	4H12420494
C518	Electrolytic, 47 mfd.,4V	4H12420582
C523	Electrolytic, 47 mfd.,40V	4H12420487
C524	Electrolytic, 47 mfd.,10V	4H12420461
C525	Electrolytic, 33 mfd.,16V	4H12420468
C526	Electrolytic, 15 mfd.,40V	4H12420484
C528	Electrolytic, 680 mfd.,40V	4H12420534
C536	Electrolytic, 4700 mfd.,63V	5H12474071
C537	Electrolytic, 10 mfd., 25V	4H12420476
C539	Electrolytic, 10 mfd.,25V	4H12420475
C541	Polyester Film, 1.5 mfd.,10%,100V	4H12140452
C542	Electrolytic, 10 mfd.,25V	4H12420475
C544	Electrolytic, 470 mfd.,6.3V	4H12420457
C550	Electrolytic, 15 mfd.,40V	4H12420484
C551	Electrolytic, 10 mfd.,63V	4H12420496
C554	Electrolytic, 4.7 mfd.,63V	4H12420494
C557	Ceramic, 68 pf.,2%,100V (N750)	4H12231076
C560	Electrolytic, 470 mfd.,25V	4H12420527
C561	Polyester Film,5.6 nf.,10%,630V	4H12140402
C563	Ceramic, 100 pf.,10%,100V (N750)	4H12231081
C565	Electrolytic, 680 mfd.,63V	5H12474017
C566	Polyester Film,4.7 mfd.,10%,100V	4H12140461
C567	Polyester Film,6.8 mfd.,10%,100V	4H12140463
C568	Polyester Film,4.7 mfd.,10%,100V	4H12140461
C572	Polyester Film,1 mfd.,10%,100V	4H12140447
C576	Electrolytic, 1[illegible] mfd.,16V	4H12420467
C578	Electrolytic, 4.7 mfd.,63V	4H12420494
C579	Electrolytic, 4.7 mfd.,63V	4H12420494
C581	Electrolytic, 330 mfd.,10V	4H12420465
C585	Electrolytic, 10 mfd.,63V	4H12420496
C587	Electrolytic, 22 mfd.,63V	4H12420499
C588	Electrolytic, 2 x 2350 mfd.,63V	4H12470198
	RESISTORS	
R636	Metal Film, 22.1K, 1%,½W	4H11651114
R637	Metal Film, 18.2K,1%,½W	5H11654382
R642	Metal Film,4.75K,1%,½W	4H11651116
R643	Metal Film,5.11K,1%,½W	4H11651115
R644	Safety, 10 ohm,5%,1/8W	4H11130405
R645	Safety, 10 ohm,5%,1/8W	4H11130405
R647	Metal Film,10K,1%,½W	5H11654327
R651	Metal Film,13K,1%,½W	4H11651158
R659	Safety,39 ohm,5%,¼W	4H11130005
R660	Metal Film,47.5K,1%,½W	4H11651117
R662	N.T.C. (Thermistor)1.5K,10%,½W	4H11630087
R664	Safety,18 ohm,5%,¼W	4H11130317
R668	Safety,4.7 ohm,5%,¼W	4H11130262
R669	Carbon Film,1 ohm,5%,1W	4H11023027
R670	Carbon Film,1 ohm,5%,1W	4H11023027
R672	Carbon Film,1 ohm,5%,1W	4H11023027
R673	Carbon Film,1 ohm,5%,1W	4H11023027
R681	Metal Film,6.8K,2%,½W	5H11654908
R682	Metal Film,18K,2%,½W	5H11654382
R684	Metal Film,100K,2%,½W	4H11651123
R700	Metal Film,24.3K,1%,½W	4H11651118
R701	Metal Film,24.3K,1%,½W	4H11651118
R702	Metal Film,47.5K,1%,½W	4H11651117
R705	Metal Film,33.2K,1%,½W	5H11654915
R707	Metal Film,3.32K,1%,½W	5H11650538
R710	Metal Film,2.21K,1%,½W	5H11654409
R714	Safety,56 ohm,5%,¼W	4H11130029
R719	N.T.C.(Thermistor),1.5K,10%,½W	4H11630087
R721	Safety,39 ohm,5%,¼W	4H11130005
R723	Safety,470 ohm,5%,¼W	4H11130013
R724	Safety,680 ohm,5%,¼W	4H11130388
R725	Safety,4.7 ohm,5%,¼W	4H11130262
R727	Carbon Film,1 ohm,5%,1W	4H11023027
R728	Carbon Film,1 ohm,5%,1W	4H11023027
R730	Wire Wound, 12 ohm,10%,4W	4H11221056
R735	Metal Film,1 meg.,5%,½W	4H11042187
R762	Wire Wound, 1.8K,5%,4W	4H11221114
	CONTROLS & SWITCHES	
R416	Input Sensitivity,200K	4H10120473
R417	High Frequency Roll Off,20K	4H10130317
R665	Current Adjust (Low Freq. Amp) 470 ohm	4H10110063
R692	Motional Feedback Adjust,47K	4H10110027
R722	Current Adjust (High Freq. Amp) 470 ohm	4H10110063
SK-A-1	AC Power Switch	4H27610564
SK-B-11	Channel Selector Switch	4H27610616
SK-D-111	Automatic Switch	4H27610616
SK-E-1V	Input Impedance Switch	4H27890303
	SEMICONDUCTORS	
D461	Silicon Diode, BAW62	5H13030613
D462	Zener Diode, BZY881C18V	5H13030304
D465	Silicon Diode, BAW62	5H13030613
D466	Silicon Diode, BAW62	5H13030613
D470	Zener Diode, BZX791C18V	5H13044286
D471	Silicon Diode, BAW62	5H13030613
D472	Silicon Diode, BAW62	5H13030613
D473	Silicon Diode, BAW62	5H13030613
D474	Zener Diode, BZX791C4V7	5H13034174
D475	Silicon Diode, BAW62	5H13030613
D476	Silicon Diode, BAW62	5H13030613
D477	Silicon Diode, BAW62	5H13030613
D480	Light Emitting Diode (LED),CQY24	4H13030922
D481	Silicon Bridge Rectifier,BY164	5H13030414
D482	Silicon Bridge Rectifier, BY164	5H13030414
D483	Silicon Bridge Rectifier, BY164	5H13030414
TS421	PNP Silicon,BC558B	5H13044197
TS422	PNP Silicon,BC558	4H13040941
TS423	PNP Silicon,BC558A	4H13040962
TS424	PNP Silicon,BC558A	4H13040962
TS425	NPN Silicon,BC548	4H13040938
TS426	NPN Silicon,BC548A	4H13040948
TS428	PNP Silicon,BC558B	5H13044197
TS429	PNP Silicon,BC558B	5H13044197
TS430	NPN Silicon,BC548	4H13040938
TS431	NPN Silicon,BD137	5H13040664
TS432a/b	Darlington Matched Pair,BDX65A/01-BDX64A/01 (MJ3001 - MJ2501)	4H13041115
TS436	NPN Silicon,BC549	4H13040964
TS437	PNP Silicon,BC559A	4H13041052
TS438	NPN Silicon,BC547	5H13044257
TS439	NPN Silicon,BC548B	4H13040937
TS440	NPN Silicon,BC548B	4H13040937
TS441	PNP Silicon,BC558A	4H13040962
TS442	NPN Silicon,BC548	4H13040938
TS443	NPN Silicon,BC546	4H13041001
TS444a/b	Darlington Matched Pair,BD267A-BD266A	4H13041045
TS446	NPN Silicon,BC550C	4H13041096
TS447	Silicon,N-Channel FET,BF245B	4H13041024
TS448	NPN Silicon,BC548C	5H13044196
TS449	NPN Silicon,BC548B	4H13040937
TS450	NPN Silicon,BC548B	4H13040937
TS451	NPN Silicon,BC548	4H13040938

ELECTRICAL REPLACEMENT PARTS LIST (Con't)

REF.	DESCRIPTION	PART NO.
TS452	NPN Silicon,8C639	4H13041063
TS455	NPN Silicon,8C546	4H13041001
TS456	PNP Silicon,8S568	5H13044247
	MISCELLANEOUS	
RE402	Relay	4H28060437
S404	Speaker (Woofer) AD10100/MF84	4H24060077
S405	Speaker (Mid-Range) AD0210/SO8	4H24050095
S406	Speaker (Tweeter) AD0160/T8	4H24070004
VL408	Fuse,3 Amp,Slow Blow	4H25330047
VL409	Fuse, 1.5 Amp, Slow Blow	4H25330046
VL410	Fuse, 6.25 Amp, Slow Blow	5H25354015

REF.	DESCRIPTION	PART NO.
	Mica Insulator f/TS432a & TS432b (2 used)	5H46690433
	Mica Insulator f/TS444a & TS444b (2 used)	4H25540112
	Insulator Bushing f/TS432a, TS432b, TS444a, & TS444b (6 used)	4H53251043
	8 Pin Socket	4H26750221
	8 Pin Plug	4H26460081
	Fuse Holder (3 used)	4H25640048
	AC Inlet (Interlock)	4H25520062
	Jack Assembly (Input/Output)	4H26740222
	AC Outlet	4H26730256
	Disc Cam f/SK-E-1V	4H53260643
	Acoustic Gasket f/S404	4H53280644

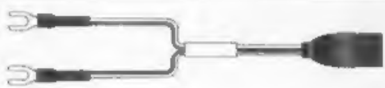
DESCRIPTION	ILLUSTRATION	PART NO.
Stereo Cable		4H32120344
Adapter Cable		4H32120331
AC Power Cable		4H32110092

Figure 12, Cable Chart